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AUTHOR Lines, Catherine; Keenan, Verne
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ABSTRACT

The effectiveness of three strategy training methods was compared with 15 learning disabled (LD) children of two age groups (9 to 10 and 11 to 12 years old) and 15 nonLD children in the same age group. The methods (practice, in which the Ss were to find the best way to remember; specific strategy method, in which the Ss used a specific cumulative rehearsal strategy; and a metamemory method, in which Ss were trained in a self instructional, self monitoring strategy) were compared for effectiveness in increasing efficiency of verbal rehearsal strategies during actual training (immediate effects), on a delayed test of the task in which training occurred (maintenance effects), and on a delayed test on a nontrained task (generalization effects). Findings revealed that both LD groups employed rehearsal strategies, but not as efficiently as same aged controls. There appeared to be a lag in the development of strategies in LD Ss. Training methods did not differ in effectiveness, but training resulted in more efficient strategy use during actual training trials and in better performance on the nontrained task for all Ss. Metamemory (the individual's knowledge of and awareness of memory) knowledge on task and strategy variables did not differ between LD and nonLD Ss, but older LD Ss did not have as much confidence in their memory abilities as older normal and younger LD Ss. Younger LD Ss were not as aware of the need for strategy implementation or of other tasks when rehearsal might be an efficient strategy, indicating some delay in development of metamemory understanding. (Author/CL)

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VERBAL REHEARSAL STRATEGIES AND METAMEMORY IN LEARNING DISABLED CHILDREN

Catherine Lines
Cherry Creek Schools, Englewood, Colorado

Verne Keenan
University of Colorado, Boulder, Colorado

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(abstract)

Learning disabled and non-learning disabled children of two age groups (9-10 years and 11-12 years) were administered two short-term memory tasks, free recall with pictures and serial recall with letters, in order to assess verbal rehearsal strategies. Then three different strategy training methods were compared as to the effectiveness in increasing efficiency of verbal rehearsal strategies during actual training (immediate effects), on a delayed test of the task on which training occurred (maintenance effects), and on a delayed test on a non-trained task (generalization effects). The three methods were a practice method, which was to find the best way to remember, a specific strategy method, which was a specific cumulative rehearsal strategy, and a metamemory method, which was training in a self-instructional, self-monitoring strategy. General metamemory was assessed by a questionnaire developed by the experimenter and specifically, as metamemory related to actual memory task performance, through post-task inquiry sessions. Results were that both age groups of learning disabled children did employ rehearsal strategies, but not as efficiently as same-aged non-learning disabled children and there seemed to be a "developmental lag" in the development of strategies in learning disabled children. Training methods did not differ in effectiveness, but training resulted in more efficient strategy use during actual training trials and in better performance on the non-trained task for all children. Metamemory knowledge of task and strategy variables did not differ between learning disabled and non-learning disabled children, but older learning disabled children did not have as much confidence in their memory abilities as older normal and younger learning disabled children. Younger learning disabled children were not as aware of the need for strategy implementation or of other tasks when rehearsal might be an efficient strategy, indicating some delay in development of metamemory understandings.

Paper presented at the American Psychological Association Convention, Los Angeles, 1981.

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Catherine Lines
Cherry Creek Schools, Englewood, Colorado

Verne Keenan
University of Colorado, Boulder, Colorado

Verbal rehearsal has been defined as a "control process" by Atkinson and Shiffrin (1968) which ". . . are transient phenomena under control of the subject. Their appearance depends on such factors as instructional set, experimental task, and past history of the subject" (pg. 24). Thus, because of the individual's control of verbal rehearsal strategies, their use has been investigated by developmental psychologists and with different populations, specifically the mentally retarded and the learning disabled.

Verbal rehearsal strategies have been found to develop with age or as Hagen, Jongeward, and Kail (1975) conclude, "the flexibility and adaptability in the use of control processes such as verbal rehearsal changes and grows throughout development." Flavell (1970) has theorized an explanation of the developmental trends in rehearsal (and other control processes) which is as follows: First, there is a total absence of a strategy, a <u>mediational</u> deficiency; second, an ability to use the strategy when instructed to do so, but not spontaneously, a <u>production deficiency</u>; third,

spontaneous generation of a task-appropriate strategy, but not consistently or with total effectiveness, a production inefficiency; and fourth, with sufficient practice, consistent and optimal efficiency, optimal production.

Children of 4 and 5 years of age do not seem to spontaneously implement deliberate verbal rehearsal strategies (Flavell, Beach, and Chinsky, 1966; Hagen and Kingsley, 1968), whereas, those six and seven (approximately first-grade) seem to be in a period of transition where they are able to implement rehearsal with prompting but to revert back to non-rehearsing when prompting ceases (Hagen, Hargrove, and Ross, 1973; Keeney, Cannizzo, and Flavell, 1967). By 8 years of age, or approximately third grade, spontaneous rehearsal strategies appear to be in evidence as measured by primacy and overt rehearsal (Ornstein, Naus, and Liberty, 1975; Allik and Siegel, 1976). However, verbal rehearsal strategies continue to develop throughout the middle childhood years, becoming more efficient, flexible, and complex (Belmont and Butterfield, 1969, 1971a; Kellas, McCauley, and McFarland, 1975; Naus, Ornstein, and Aviano, 1977; Ornstein, Naus, and Stone, 1977).

In studies with the mentally retarded, Ellis (1970) found that this group was equal to normals on recency serial positions, but severely deficient on primacy, because of a failure to implement verbal rehearsal strategies. Similarly,

Belmont and Butterfield (1969, 1971a, 1971b) found that the mentally retarded failed to pause on primacy items as did normals who use a "cumulative rehearsal, fast finish strategy", thus indicating a lack of verbal rehearsal.

Children with learning disabilities, much like the young and mentally retarded, have been found to have deficient verbal rehearsal strategies. Using the serial probe task (Hagen and Kingsley, 1968), Tarver and her associates (Tarver, Hallahan, Kauffman and Ball, 1976; Tarver, Hallahan, Cohen, and Kauffman, 1977) reported a lack of verbal rehearsal strategies in young learning disabled children, as measured by a lack of primacy effects, but that the older children did display such strategies, thus concluding that learning disabled children had a "developmental lag" in the development of verbal rehearsal as compared to normal children of the same chronological and mental age. Bauer (1977a; 1977b, and 1979), also concludes that the learning disabled child has inadequate elaborative encoding strategies, documented by his findings that on traditional free recall tasks, learning disabled children have deficient primacy and total recall, but are equal in recency, and that on tasks demanding no verbal rehearsal, the learning disabled child's performance is equivalent to that of normal children.

Torgeson (Torgeson, 1977b, and Torgeson and Goldman, 1977) analyzed verbal rehearsal as one of several active

mne monic strategies which children can implement to improve recall. These studies found that reading disabled children do not actively attempt to memorize stimuli using verbal rehearsal strategies, whereas normal-learning children do apply such strategies. Torgeson (1977a) theorized that this lack of verbal rehearsal strategy implementation stems from one major characteristic of learning disabled children, which he terms as "inactive learning", with their primary deficit being one of performance, or the failure to actively engage in learning. The active learner, says Torgeson, demonstrates puposive adaptation to tasks, enacts appropriate strategies for learning, and is aware of his own cognitive processes (i.e. meta- variables, such as metamemory). The inactive learner, alternately, passively processes information, doesn't participate in consistent active strategy implementation, and remains unaware of his own process and abilities. Torgeson's theory specifies that the learning disabled child's experiential learning history enters into his inactive learner status in that his cumulative failures and frustrations with academic tasks have made him dependent on others in intellectual activity and lacking in "intent to learn" or active strategy use.

The importance of the Atkinson and Shiffrin control process perspective is that it suggests the possibility of training and remediation and attempts at training those

deficient in verbal rehearsal strategies have been made. The focus of such "instructional strategy training" (Belmont and Butterfield, 1977) can be to induce verbal rehearsal immediately during training, exact maintenance of a rehearsal strategy over time with a delayed test, or to encourage generalization of a trained rehearsal strategy to another, similar, but different task. Inducement of verbal rehearsal strategies during training has been successfully enacted with the developmentally young, (Keeney, Cannizzo, and Flavell, 1967; Kingsley and Hagen, 1968) the mentally retarded, (Belmont and Butterfield, 1971; Butterfield and Belmont, 1972) and the learning disabled (Torgeson, 1977b, and Torgeson and Goldman, 1977). Maintenance of a trained verbal rehearsal strategy by testing after a delay has also successfully been implemented with the young (Kennedy and Miller, 1976; Asarnow and Meichenbaum, 1979) and the mentally retarded (Brown, Campione, Bray, and Wilcox, 1973; Brown, Campione, and Murphy, 1974). With the former group, a metamemory component or self-instructional and self-monitoring training seemed to result in successful maintenance of the trained strategy. In the mentally retarded, extensive training seemed helpful (Turnbull, 1974; Kellas, Ashcraft, and Johnson, 1973).

Only one study (Brown, Campione, and Barclay, 1979) focused on generalization of a trained rehearsal strategy to

another task. They successfully taught mildly mentally retarded subjects to implement metamemorial self-checking and study monitoring (rehearsal and anticipation) skills for a free recall and recall readiness task and then a year later tested for generalization on a prose-passage task, with the result that the children had retained the rehearsal and anticipation strategies and were able to apply them to a new task. Brown et al. (1979) stated that "the type of self-interrogation which we think might work is to provide the child with a routine set of questions to ask himself before proceeding, for example (a) Stop and Think! (b) Do I know what to do? (i.e. understanding the instructions, both explicit and implicit)? (c) is there anything more I need to know before I can begin? and (d) is there anything I already know that will help me (i.e. is this problem in any way like one I have done before?" (pg. 510).

Metamemory, a relatively new concept in the developmental literature, is defined by Flavell and Wellman (1977) as "the individual's knowledge of and awareness of memory, or of anything pertinent to information storage and retrieval" (pg. 4). Three major categories of metamemory knowledge have been proposed by Flavell and Wellman (1977) and are as follows: (1) person variables such as enduring abilities and traits of memory (primary memory limitations and a "mne monic self-concept") and the ability to monitor ongoing

memory processes (tip-of-the tongue feelings, etc.), (2) task variables such as that some information is harder to remember than other information (longer lists, unfamiliar words) or that time plays an important part in memory behavior (more difficult to retain over longer time periods), and (3) strategy variables such as that certain control processes are more effective than others for certain tasks and that there are different memory strategies available (rehearsal, imaging, etc.). Investigators have found that all these metamemory variables seem to develop with age, with practice in deliberate memorizing, feedback as to the effectiveness of various techniques, experience with a wide variety of tasks (Kreutzer, Leonard, and Flavell, 1975) and that this development is probably related to a child's school experiences (Flavell and Wellman, 1977).

The lack of metamemory knowledge has been theorized by Torgeson (1977a) as being a possible reason for learning disabled children's "inactive" learning, failure to implement active verbal rehearsal strategies, and consequent less efficient learning. Brown (1978) has postulated that training in metamemory skills which would have "broad generalizeability" across a variety of intentional memory situations is necessary to the generalization of trained rehearsal (and other control strategies) to other tasks. Thus the metamemory construct is being applied to both verbal rehearsal

deficiencies, at least theoretically, and to the remediation of such deficiencies through training.

The purpose of the current study, which draws upon the above stated literature, is three-fold. One, it will attempt to replicate findings that learning disabled children are deficient in the control process of verbal rehearsal as compared to same-aged normal learning children. Children of two different ages groups will be involved so that the finding of a "developmental lag" can be explored. Two, Torgeson's (1977a) theorized explanation of the reason for the learning disabled child's verbal rehearsal deficiency, that of being "inactive" and lacking in metamemorial knowledge, will be tentatively explored by measuring general metamemory knowledge on a questionnaire tapping the three major metamemorial categories and by post-task inquiry as to specific metamemorial knowledge of the memory tasks. Three, different verbal rehearsal strategy training methods will be compared as to effectiveness in each of immediate facilitation of rehearsal strategies (during training session), maintenance of the trained strategies over time (delayed test on a trained task, free recall) and generalization of the trained strategies to a different task (serial recall) so as to discover the most effective way to remediate the verbal rehearsal deficits in learning disabled children. The three training methods can be thought of as a continuum of inter-

vention, with a practice condition (Asarnow and Meichenbaum, 1979) being minimal intervention with freedom to develop own strategy, a specific strategy method (Naus, Ornstein, and Stone, 1977) which gives specific instruction, and a meta-memory method (Brown, et al, 1979) which is training in a self-instructional routine.

METHOD

Subjects. Subjects were 60 children of two age groups (9-10 years and 11-12 years) from two suburban middle class elementary schools. Fifteen children from each age group had been previously diagnosed as being learning disabled by school staffing committees in accordance with the Colorado Handicapped Children's Act of 1973 and following the definition given in The Education for All Handicapped Childrens Act, Public Law 94-142 (1975).

The specific school district guidelines for identifying learning disabled children were that they must have significant deficits in two academic areas and two communicative or perceptual difficulties as measured by standardized test criteria. These thirty learning disabled children were currently receiving special education services in a learning disability resource room. The other thirty children were selected to match the learning disabled children on age, sex, and school of attendance. A stratified sampling pro-

cedure was implemented using ability levels as measured by the Cognitive Abilities Test Non-Verbal Score, with the selected sample being as proportionate to that of a normal distribution of intellectual functioning as possible. All the non-learning disabled children were achieving at or above grade level.

No children with diagnosed emotional disorders, physical handicaps, or visual or hearing losses were included in the study. Only children with Non-Verbal scores on the Cognitive Abilities Test of 80 or above were included. A summary of the means, and standard deviations for age, ability and achievement for the four subject groups, young learning disabled (YLD), old learning disabled (OLD), young non-learning disabled (YNLD), and old learning disabled (ONLD) are given in Table 1. Chance differences only, were found among these groups on the Cognitive Abilities Test, $F(3,76)=1.69$.

Memory Tasks and Metamemory Measures. Memory tasks were oral free recall with pictures, and oral serial recall with letters, following visual presentation. Pictures and letters were initially presented face down on a large display board and then turned over one-by-one at five-second intervals, the already revealed letters or pictures remaining in view. Then the board was covered and recall requested.

TABLE 1

SUBJECT GROUP MEANS AND STANDARD DEVIATIONS
FOR AGE, ABILITY, AND ACADEMIC ACHIEVEMENT

Group	Age		Cognitive Abilities Test Non-Verbal		Gates-McGinitie Reading Test		Iowa Test of Basic Skills	
	M	SD	M	SD	M	SD	M	SD
YLD	109.1	5.93	99.5	9.69	2.3	.55	2.6	.50
OLD	129.9	6.85	96.9	15.09	3.2	.75	3.3	.48
YNLD	110.9	4.63	105.4	9.88	4.8	1.32	4.0	.60
ONLD	131.1	6.97	104.1	11.70	5.9	1.57	5.6	.96

Note: Age means are given in months, Cognitive Abilities Test in standard scores, and achievement test means in grade equivalents.

For the free recall task, pictures were selected from a pool of 90 black and white line drawings on 3x5 cards from the Peabody Picture Vocabulary Test, with no picture being used more than once per session. Criteria for selection were: (1) one syllable labels (see Allix and Siegal, 1976), (2) similar values on semantic dimensions (see Raymond, 1969) (all pictures had labels in either Cluster 7 or 8 of the Toglia and Battig (1978) word norms), (3) minimal categorical association between words within a list (see Cole, Frankel, and Sharp, 1971), and (4) phonemically similar labels separated by several words within lists (see Conrad, 1973). For the free recall task, any item recalled in any order was scored as correct. Fifteen pictures were included in a trial. Trial lists were the same for pre- and post-intervention, with different trial sequences for the training sessions. Practice lists were colored pictures.

For the serial recall task, stimuli were the letters of the alphabet (with the exception of W). Black upper case letters were shown on individual 3x5 cards. Criteria for lists were: (1) minimal phonemic similarity, i.e. letters such as B and D were separated by at least three phonemically distinct letters, (2) no two letters appearing twice, and (3) no two letters appeared in sequence which were given as first associations in the norms of Underwood and Schul z (1960). Practice trials were composed of digits, rather

than letters. Scoring was by a strict criterion (Martin, 1978), by which an item was correct only if it was recalled in the exact input serial order. Twelve letters were included in a trial and trial lists were the same for pre- and post-intervention sessions.

The metamemory questionnaire was composed primarily of questions taken from the literature (Flavell and Wellman, 1977; Leonard, Kreutzer, and Flavell, 1975, Naus and Dennig, cited in Naus and Halasz, 1979), with a few added by the experimenter. The questions were selected to tap metamemory knowledge in the three areas of strategy, task, and self-concept and rephrased into a forced-choice format. The final metamemory instrument resulted from pilot administration and item analysis. The questionnaire, as used in the study, is given in Appendix A. The questions used for the post-task inquiry were taken from various developmental studies (Allik and Siegal, 1976; Naus, Ornstein, and Kreshtool, 1977; Torgeson and Goldman, 1977). The post-task inquiry was designed to tap the three theorized subcategories of metamemory knowledge and the questions for each session are given in Appendix B.

Procedure. Children in the study were seen individually a total of three times, for three consecutive weeks, each session being approximately one-half hour in length. The testing and training session sequence is summarized in

Table 2. Within each learning-age group, (young learning disabled, old learning disabled, young non-learning disabled, and old non-learning disabled) children were randomly assigned to one of the three rehearsal strategy training conditions, practice, specific strategy, or metamemory. The pre- and post-intervention sessions were identical for all children. Instructions for the serial recall task were:

> This is the first memory game. I will show you some letters, one at a time, and then cover them all. When I say "NOW", I want you to tell me all of the letters that you can remember in the exact same order that you saw them. This is a difficult game and you are not expected to get them all correct. Try and remember as many as you can. Let's try one for practice, only we will use numbers. Remember try and remember them in the exact same order that you see them.

Instructions for the free recall task were as follows:

> This is another memory game. I will show you some pictures one at a time and then cover them all. When I say "NOW", I want you to tell me all of the pictures that you can remember in <u>any order</u>. Try and remember as many as you can. This game is different from the letter game in that you can remember the pictures in any order--just tell me all of the pictures you can remember. This game is difficult too, so just try and remember as many as you can. Let's try one for practice with colored pictures. For the real game, we will use pictures that are black and white.

Training session instructions differed according to the training conditions and are described for each training method.

<u>Practice Training Condition</u>. Instructions to the children in the practice condition for the training task, free recall with pictures, were as follows:

TABLE 2

TESTING AND TRAINING SEQUENCE

Pre-Intervention Session (Week 1)	Training Session (Week 2)	Post-Intervention Session (Week 3)
1. Introduction	1. Training Explanation	1. Serial Recall - Generalization Task 1 Practice Trial 4 Test Trials
2. Metamemory Questionnaire	2. Free Recall - Training and Maintenance Task 1 Practice Trial 6 Training Trials	2. Free Recall - Training and Maintenance Task 1 Practice Trial 4 Test Trials
3. Serial Recall - Generalization Task 1 Practice Trial 4 Test Trials	3. Post-Task Inquiry	3. Post-Task Inquiry
4. Free Recall - Training and Maintenance Task 1 Practice Trial 4 Test Trials		
5. Post-Task Inquiry		

We are going to play one of the memory games again--the picture game. As we do the game this time, I want you to find the best way for you to remember the pictures that you can so you can get as good as you can at the game. Whatever you decide to do to help you learn the pictures, do it out loud so that I can hear you. Let's try some for practice. Remember, with the picture game, I turn the cards over one at a time. Then when I get to the end, I'll cover them and say, "Now". Then you tell me all you can remember in <u>any order</u>. Remember, whatever you decide to do to help you learn the pictures, do it out loud, so that I can hear you. This one will be for practice--so that you can think about the best way for you to remember pictures and so you can practice doing your way out loud.

<u>Specific Strategy</u>. For the specific strategy condition, training instructions were as follows:

Today, we are GOING TO PLAY ONE OF THE MEMORY GAMES again--the picture game. Remember, with the picture game, I turn the cards over one at a time, then when I get to the end, I'll cover them and say, "NOW". Then you tell me all that you can remember in any order. This time though I'm going to teach you a trick that will help you to remember the pictures, so that you can get as good as you can at the memory game. This trick works like this. Whenever I turn over a new picture, say the name of the picture, and then as many of the other ones that you can. Always say the new picture, and then at <u>least</u> two old ones, but more than that if you can. Keep doing this for each new picture and <u>always</u> be saying some of the picture names. The trick is called "NEW-OLD". <u>Always</u> say the picture names out loud as you are practicing them. We'll do two game for practice, so that you can see how to do the NEW-OLD trick and practice doing it out loud. I'll show you first, then you can try it.

<u>Metamemory Training Condition</u>. The instructions for this training condition were as follows (a metamemory training chart used to depict the <u>Stop and Think</u> plan was also used):

Today, we are going to play one of the memory games again--the picture game. Remember, with the picture game, I turn the cards over one at a time, then when I get to the end, I'll say "NOW". Then you tell me all the pictures that you can remember in any order. Before we play the game today though, I'm going to tell you some things about how your own memory works and then teach you a plan that can help you get as good as you can at the memory game.

When you have to remember things for a short time, you have to keep them going around and around in your head, otherwise they disappear and you forget them. It's just like if I told you a phone number to call right away, you would probably have to say it over and over to yourself to remember it. Let's try an example. Here is a phone number for you to remember, 750-9343. What are you doing to remember it? Probably saying it over and over, right? It works the same way when the teacher gives you instructions in class. So, when you have to remember things for just a short time, like in the picture game, <u>you have to keep them in your head by saying them over and over</u>, or else they disappear.

There is a plan that can help you to remember a lot of different things and know about your own memory. You ask yourself questions about what you have to remember and what you can do to remember, and what is going on in your own head. It is called the <u>STOP and THINK</u> plan--you have to really think about what you are doing and what is in your own head. You do it each time that you have to remember things. By doing this plan you can get as good as you can at the memory games.

Here is the plan --the STOP and THINK plan.

First, you <u>stop and think</u>,

Then, remember that when you remember things for a short time, you have to keep them in your head by saying them over and over, or else they disappear--like the phone number.

Then, ask yourself these questions to help you know what is in your own head.

What do I have to remember? (so you know what you have to remember.)

Then answer, "The pictures in any order."

What can I do to remember the pictures? (so you know what will help you.)

Then answer, "Well for me, say as many picture names as I can, over and over all the time--saying the one turned over first and then as many more as I can."

Do It! PLAY THE GAME AND REMEMBER AS MANY PICTURES AS I CAN!

What did I do? (so you know what you did to remember the pictures).

Did it work? (so you think about how it worked in helping you to remember the pictures.)

This is the STOP and THINK PLAN -- so you know what you are doing to remember the pictures and what is in your own head. You do it each time you have to play a memory game and each time you have to remember something.

It will help you to get as good as you can at the memory games and help you to be a good memorizer.

RESULTS

For each session, recall scores were averaged across trials and analyses were performed on serial position and each of pre-recency (defined as the first two-thirds of the presented list, recency (defined as the last third of the presented list), and total recall (defined as both pre-recency and recency combined). The original analyses of the data implemented a 2 (learning group, learning disabled and

non-learning disabled) x 2 (age, young and old) x 3 (training method, practice, specific strategy, and metamemory) design for both free and serial recall tasks. Non-learning disabled children were superior in all comparisons, with the exception of recency items on the serial recall task. Older children were superior in all comparisons on the free recall task, with the exception of recency items during pre-intervention and pre-recency items during the training session. For serial recall, the older children did signficantly better on the post-intervention session, but not during pre-intervention. In order to specify developmental relationships between the four learning-age groups, 4 (learning-age group, young learning disabled, old learning disabled, young non-learning disabled, and old non-learning disabled) x 3 (training method) analyses of variance were applied to the data and are reported in detail below.

Free Recall (Training and Maintenance Task). During pre-testing, the four learning-age groups differed significantly on pre-recency, $F(3,48)=9.13, p < .01$, recency, $F(3,48)=5.29, p < .01$, and total recall, $F(3,48)=11.67, p < .001$. The Newman-Keuls test specified that on pre-recency, both older and younger learning disabled performed less well than their same-aged controls ($p < .05$) and also, that within the learning disabled group, the older recalled significantly more than the younger children ($p < .05$). The same was true for

total recall, with the additional finding that the older non-learning disabled recalled more than the younger ($p < .01$). For the recency portion of the list, the Newman-Keuls test indicated that the older non-learning disabled children were better than the other three groups ($p < .01$) which did not differ from each other. Table 3 summarizes means and standard deviations for pre-recency, recency, and total recall for the four learning groups during the three sessions. When serial position was analyzed with a 4x3x15 (serial position) analysis of variance with repeated measures on the last factor, group differences were significant, $F(3,48)=11.02$, $p < .001$, as was serial position, $F(14,672)=31.98$, $p < .001$, but the interaction was not, $F(42,672)=.84$. Figure 1 depicts the mean percentage correct during pre-intervention and training sessions as a function of serial position.

During the training session, learning-age groups continued to perform differently on pre-recency, $F(3,48)=3.48$, $p < .025$, recency, $F(3,48)=6.88$, $p < .001$, and total recall, $F(3,48)=7.17$, $p < .001$. On pre-recency and total recall, the Newman Keuls test found that with the training intervention (all methods), the younger learning disabled children were equal in performance to the normal-learning controls, the only difference being between the older non-learning disabled group and the younger learning disabled ($p < .05$). On recency, however, the older non-learning disabled group continued to

TABLE 3

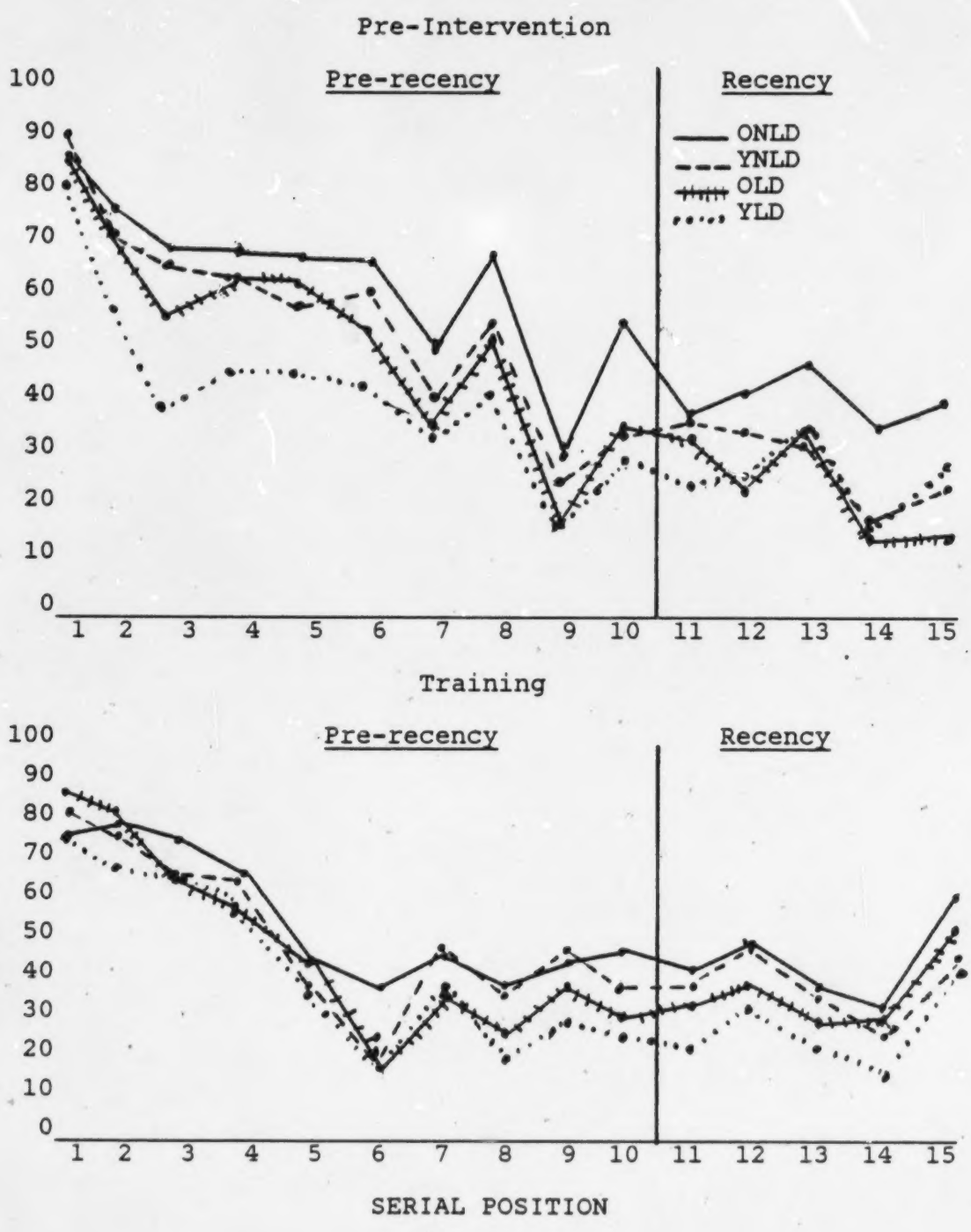
MEANS AND STANDARD DEVIATIONS ON THE TWO TASKS
FOR THE FOUR LEARNING-AGE GROUPS
DURING THE THREE SESSIONS FOR
PRE-RECENCY, RECENCY, AND TOTAL RECALL

	SESSION									
	Pre-Intervention				Training		Post-Intervention			
	Free Recall		Serial Recall		Free Recall		Free Recall		Serial Recall	
	M	SD	M	SD	M	SD	M	SD	M	SD
Pre-Recency										
YLD	4.23	1.08	3.03	1.19	4.18	.93	4.40	.99	3.67	1.32
OLD	5.13	1.09	3.37	1.38	4.67	1.12	5.55	1.34	4.57	1.37
YNLD	5.53	1.03	4.40	1.53	4.94	.98	5.53	1.24	4.53	1.12
ONLD	6.15	.86	4.32	.90	5.42	1.21	6.43	1.20	5.17	1.54
Recency										
YLD	1.35	.35	.08	.12	1.42	.53	1.15	.86	.08	.18
OLD	1.28	.77	.08	.20	1.73	.75	1.32	.78	.20	.39
YNLD	1.40	.72	.18	.24	2.00	.51	1.52	.89	.08	.15
ONLD	2.13	1.01	.17	.29	2.26	.55	2.22	.93	.57	.80
Total										
YLD	5.58	1.16	3.12	1.18	5.60	1.04	5.55	1.44	3.75	1.30
OLD	6.42	1.57	3.45	1.42	6.43	1.57	6.85	1.61	4.77	1.61
YNLD	6.92	1.27	4.38	1.43	6.95	1.31	7.05	1.73	4.62	1.15
ONLD	8.28	1.09	4.48	1.02	7.69	1.23	8.65	1.57	5.73	2.16

Note: For free recall, there were a total of 15 items, 10 on pre-recency and 5 for recency. For serial recall, there were a total of 12 items, 8 on pre-recency and 4 for recency.

FIGURE 1

MEAN PERCENTAGE CORRECT ON FREE RECALL FOR LEARNING-AGE GROUPS DURING PRE-INTERVENTION AND TRAINING SESSION AS A FUNCTION OF SERIAL POSITION



be superior to all other groups ($p < .01$) and also the younger non-learning disabled recalled more than their learning disabled peers ($p < .01$). No training method differences were found, nor were there any interactions between learning-age group and serial position.

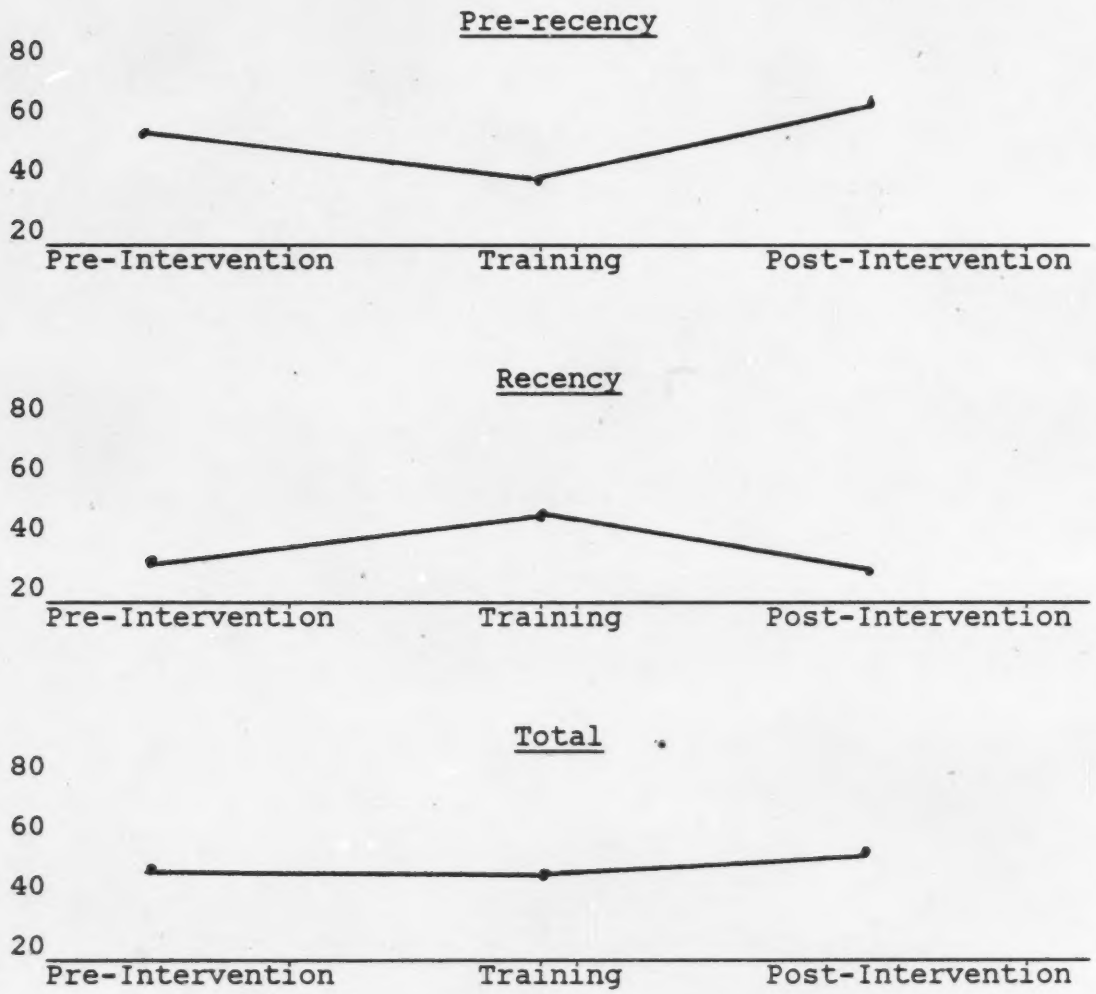
The post-intervention (delayed maintenance) scores resulted again in significant learning-age group effects for pre-recency, $F(3,48)=6.94, p < .01$, recency, $F(3,48)=4.89, p < .01$, and total, $F(3,48)=9.70, p < .001$, and again there was no main effect of training method. The Newman-Keuls test specified that for pre-recency, the younger learning disabled children were less proficient than their normal-learning controls ($p < .01$) and than the older learning disabled children ($p < .01$). Older learning disabled and non-learning disabled children did not differ. For total recall, all learning-age group differences were significant (older non-learning disabled greater than older learning disabled and younger non-learning disabled greater than younger learning disabled, $p < .05$). On recency recall scores with Newman-Keuls analysis, the older non-learning disabled children had higher recall than any of the other groups ($p < .01$). Serial position analysis with repeated measures again revealed no significant interaction between serial position and learning-age group.

Although the three training methods did not produce differential recall, it was possible that the pattern of recall across sessions might differ. Scores for the pre-intervention, training, and post-intervention sessions were entered as a repeated measure with learning-age groups and training methods as the other factors in a 4x3x3 analysis. There was a main effect for sessions on both pre-recency, $F(2,96)=14.36, p < .001$, and recency, $F(2,96)=5.09, p < .01$, but not on total recall, $F(2,96)=2.62$. The Newman-Keuls test revealed that for pre-recency, the pre-and post-intervention sessions were superior to the training session ($p < .01$) and oppositely, for recency, the training session was superior to the other two ($p < .01$), which did not differ from each other. Because interactions between learning-age groups and training method and sessions were not significant, these results applied to all children. Figure 2 shows mean percentage correct for the sessions on pre-recency, recency, and total recall.

Serial Recall (Generalization Task). During the pre-testing session on the serial recall task, the 4x3 analysis of variance, on both pre-recency, $F(3,48)=4.03, p < .025$, and total analysis, $F(3,48)=3.95, p < .025$, found significant learning-age group differences. The Newman-Keuls test between means found that on pre-recency, the younger and older non-learning disabled children had higher recall than

FIGURE 2

MEAN PERCENTAGE CORRECT FOR PRE-RECENCY, RECENCY, AND TOTAL RECALL DURING SESSIONS FOR THE FREE RECALL TASK

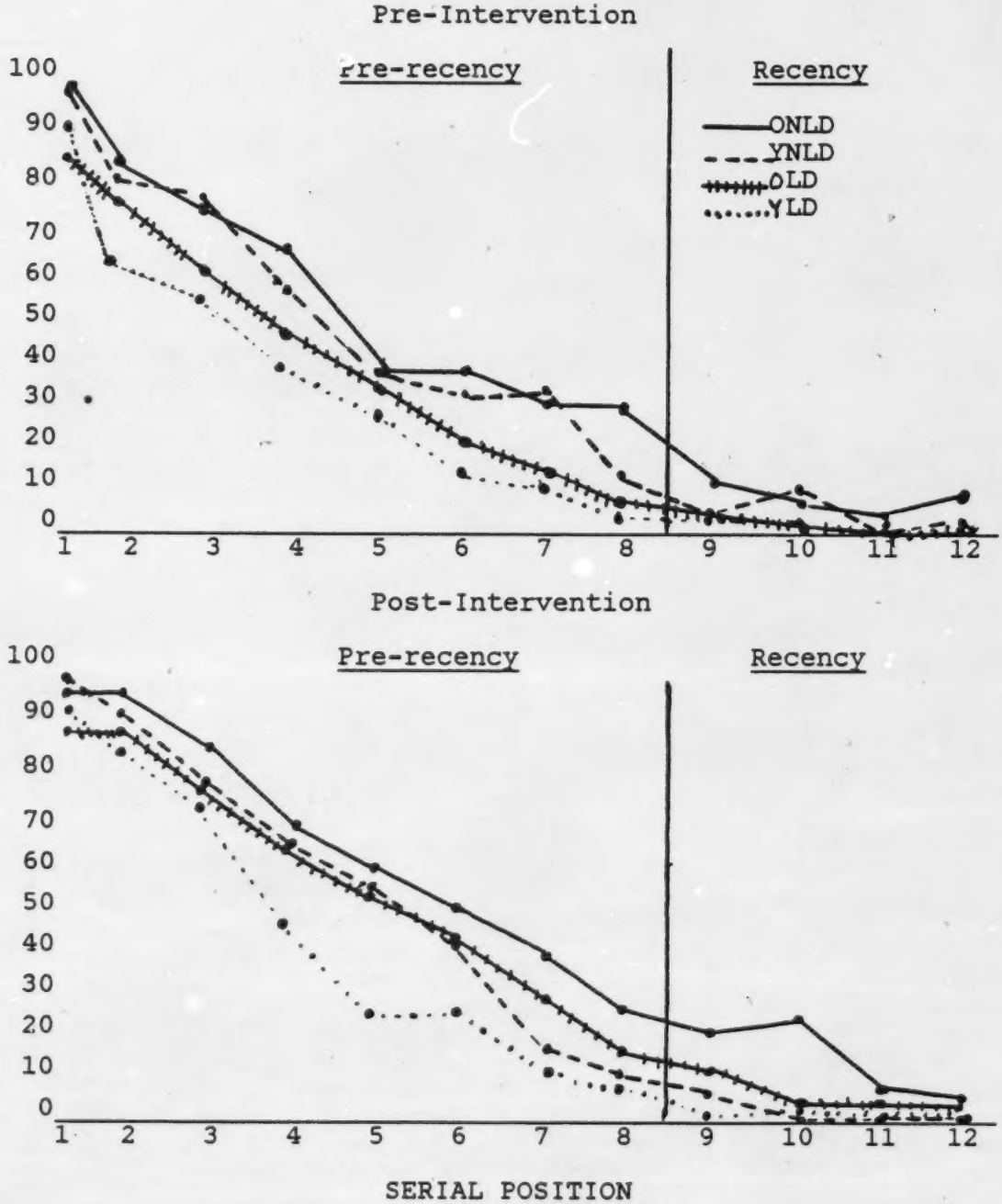


the younger learning disabled children ($p < .05$) and that on total recall both non-learning disabled groups of children performed better than their learning disabled counterparts ($p < .05$). There were no significant learning-age group differences in recency recall, $F(3,48)=1.12$. A 4x3x12 analysis of variance with repeated measures on the last factor for serial position revealed no significant learning-age group by serial position interaction, $F(33,528)=.91$. Figure 3 relates percentage correct as a function of serial position for the pre- and post-intervention sessions.

For the post-intervention session (the test of generalization of trained strategies) there were no differences in training methods, but learning-age group differences were again significant for pre-recency, $F(3,48)=3.11, p < .05$, recency, $F(3,48)=3.73, p < .025$, and total, $F(3,48)=3.80, p < .025$. However, learning disabled children were equivalent to same-aged non-learning disabled children on both pre-recency and total, the Newman-Keuls test specifying that the only significant group differences were between the older non-learning disabled children and the younger learning disabled ($p < .05$) which could be expected. The recency Newman-Keuls analysis revealed that the older non-learning disabled group had higher recall than the other three groups ($p < .05$), which did not differ from each other. Again, the serial position analysis resulted in a lack of significant inter-

FIGURE 3

MEAN PERCENTAGE CORRECT ON SERIAL RECALL FOR LEARNING-AGE GROUPS DURING PRE- AND POST-INTERVENTION SESSIONS AS A FUNCTION OF SERIAL POSITION



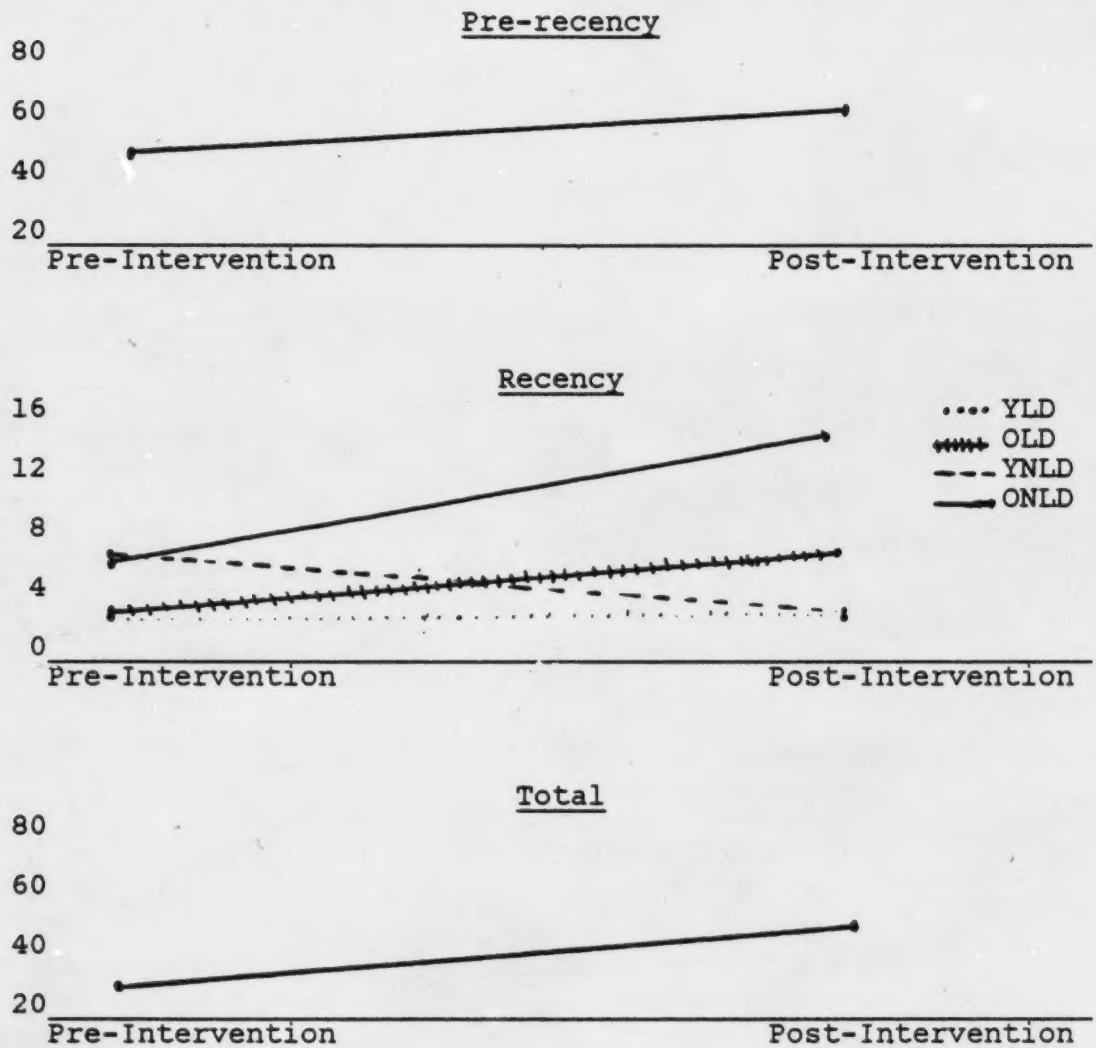
action between learning-age group and serial position, $F(33,528)=1.84$.

A 4x3x2 (sessions) analysis of variance was performed with repeated measures on the last factor. The main effects of sessions was significant with the post-test session being superior on pre-recency, $F(1,48)=11.08, p < .01$, and total recall, $F(1,48)=14.28, p < .001$, for all learning-age groups. For recency, an interaction with learning-age group and session, was significant, $F(3,48)=3.14, p < .05$. The sessions for serial recall are depicted in Figure 4.

Metamemory. A one-way analysis of variance was performed to assess response differences to the total metamemory questionnaire (Appendix A) and the three components of task, strategy, and memory self-concept. The four learning age groups did not differ on the total questionnaire, $F(3,56)=.42$, task, $F(3,56)=1.57$, or strategy, $F(3,56)=1.40$. The learning-age group effect was significant, however, on the memory self-concept portion of the questionnaire, $F(3,56)=3.59, p < .05$. The Newman-Keuls test of mean differences specified that the younger learning disabled and older non-learning disabled had significantly higher scores on this than the older learning disabled children ($p < .05$). Percentages correct on the metamemory questionnaire are shown in Figure 5. In order to assess differences on individual questions of the metamemory questionnaire, the chi

FIGURE 4

MEAN PERCENTAGE CORRECT FOR PRE-RECENCY, RECENCY, AND TOTAL RECALL DURING SESSIONS FOR THE SERIAL RECALL TASK



square statistic (with the Yates, 1934, continuity correction) was computed for each question between the various learning-age groups. Only three of the eighteen questions resulted in differences between the groups. On a question tapping knowledge of the ease of paraphrase versus rote recall, fewer younger (47%) than older learning disabled children (93%) demonstrated understanding of the concept, $\chi^2(1)=5.71, p < .02$. When asked about the effectiveness of cumulative versus rote rehearsal strategies, fewer younger learning disabled (33%) than younger non-learning disabled children (73%) answered correctly, $\chi^2(1)=4.40, p < .05$. Significantly more younger learning disabled children (93%) than older (47%) thought that they "remembered things to do at home, like chores", $\chi^2(1)=5.71, p < .02$.

On the post-task inquiry questions (Appendix B), the four learning-age groups responded similarly for the most part. The chi square statistic revealed only three questions during all the sessions where differences occurred. First, during the pre-test session, fewer younger learning disabled children (33%) than older learning disabled children (93%) responded that they had implemented any strategy in trying to remember the pictures, $\chi^2=9.12, p < .01$. Then, when asked during the post-intervention session if they could state another time they might have to "remember things like this", significantly more young non-learning disabled

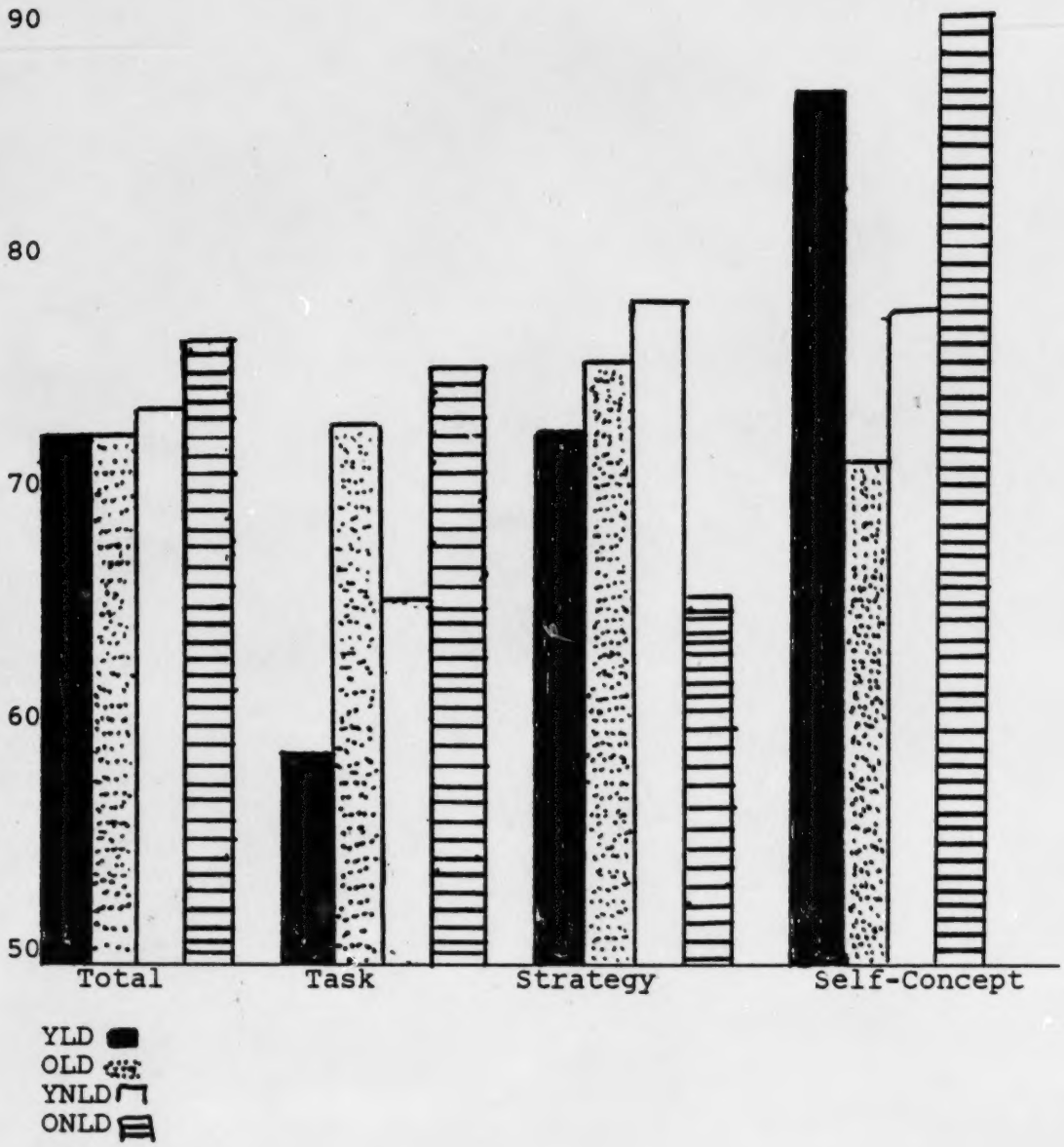
(100%) than young learning disabled children (60%) could give an appropriate example such as "remembering directions in class" or "remembering a phone number", $\chi^2=5.21, p < .05$. When asked to judge the difficulty of the memory tasks, more of the younger learning disabled children (87%) thought the task easy, than either the older learning disabled children (40%) or the young non-learning disabled (33%), $\chi^2=7.04, p < .05$ for the former and $\chi^2=9.98, p < .02$ for the latter.

DISCUSSION

Because the tasks used in this study utilized a format where stimuli were revealed one-at-a-time and then left in view for the remaining portion of the time, several general results and related interpretations which are different from the traditional literature (where stimuli are exposed only for a short time) occurred. First, almost no recency effects were evidenced, as the absence of a bow-shaped serial position curves documents. Instead, definite primacy effects were apparent, with the remaining serial positions fairly equal in percent recalled on free recall, and on serial recall, primacy effects and then a constant decline in recall. This lack of a traditional recency effect for these learning tasks may possibly stem from the nature of the tasks themselves, where earlier presented items remained in view longer than the later ones, thus increasing their

FIGURE 5

MEAN PERCENTAGE CORRECT ON METAMEMORY QUESTIONNAIRE TOTAL AND COMPONENTS FOR THE FOUR LEARNING-AGE GROUPS



probability of rehearsal and recall, not the equal presentation times of traditional free and serial recall tasks.

This lack of clear, traditional recency effects (or primary memory as these are usually interpreted) in the serial position curves and the nature of the tasks demand some changes in interpretation of pre-recency, recency, and total recall as defined in this study and as verbal rehearsal strategy is measured. Pre-recency effects can be interpreted as being evidence for verbal rehearsal strategy, but as the rudimentary, basic evidence for such a strategy. Recency, then is to be interpreted, not as recall from the "short-term store" or "echo box", but as a continuation of a verbal rehearsal strategy, where more recently presented items are rehearsed in conjunction with earlier ones. Thus recency recall can represent a more flexible, task-adaptive extension of the basic rehearsal strategy process which pre-recency seems to measure on these tasks. Efficient implementation of verbal rehearsal strategies thus is measured first by pre-recency effects, then extension of that into recency positions, and then finally, total recall serving as a measure of total strategy efficiency.

The attempt to replicate previous findings in the literature as to learning disabled children's deficiencies in the implementation of verbal rehearsal strategies, resulted in several findings which seem to expand on the

earlier results. One, learning disabled children are deficient in the use of verbal rehearsal strategies as compared to same-aged normals, but this deficiency is more visible on a task which, because of stimuli and scoring criteria, allows for more flexibility and adaptability in strategy use, such as free recall with pictures utilized in this study. Two, learning disabled children of 9 years of age and older do implement verbal rehearsal in attempts to memorize stimuli as evidenced by the primacy effects in the serial position curves and by the finding that in no analyses was any learning-age group by serial position interaction significant. Thus learning disabled children seem to be using similar strategies to those of non-learning disabled children, but not as flexibly, efficiently, or in as task-adaptive manner. Perhaps they do not have as variable rehearsal sets (Naus, Ornstein and Aviano, 1977; Naus, Ornstein, and Stone, 1977) or on the tasks used in this study, don't extend their rehearsal to include most recently presented items. Three, Tarver et al's (1976) description of a "developmental lag" in the implementation of verbal rehearsal strategies seems supported by the findings in this study, as the youngest learning disabled group is deficient as compared to the older learning disabled children who are similar to children younger than themselves (the young non-learning disabled), but are less efficient than normal-

learning children of the same age. In Flavell's (1970) terms, the learning disabled children of this age may be described as having a production inefficiency, where there is spontaneous generation of a task-appropriate strategy, but not with consistency or total effectiveness, in verbal rehearsal strategy implementation. That the oldest non-learning disabled children were superior to the other three groups on recency recall, defined as a more advanced extension of basic rehearsal processes, implies that perhaps this group alone was producing optimally and that verbal rehearsal strategies do continue to develop in efficiency with age in all children (Belmont and Butterfield, 1969, 1971a; Cuvo, 1975; Naus, Ornstein, and Aviano, 1977; Kellas, McCauley, and McFarland, 1975).

The examination of metamemory variables, as a partial explanation for learning disabled children's less efficient implementation of control strategies (Torgeson, 1977a), such as verbal rehearsal, was brief and exploratory, but the results seem indicative of general trends and of areas where future research might focus. First, learning disabled children of the two age groups used in this study, display equivalent general metamemory knowledge on task and strategy variables to that of same-aged non-learning disabled children as these variables were measured by the questionnaire used in this study. Second, learning disabled children may be

slower to develop some general metamemory understandings as to rehearsal strategy, awareness of need to implement such rehearsal in actual task performance, and awareness of tasks where rehearsal strategies may be helpful than normal-learning children, but this metamemory knowledge seems to have developed to an equivalent level to that of non-learning disabled children by 11 or 12 years of age. Third, older learning disabled children may suffer in developing adequate concepts of themselves as memorizers, perhaps because of years of learning failure as Torgeson (1977a) has stated. Metamemorial knowledge deficiencies thus may be a part of learning disabled children's strategy inefficiencies as Torgeson (1977a) postulated, but for younger learning disabled children these may be more related to a lack of needed metamemory awareness and for the older learning disabled more closely tied to a lack of personal confidence in memory abilities.

The failure to find any differences in effectiveness between the three different strategy training methods might have stemmed from several different factors. Among them are: (1) training was only for one session and this may not have been of long enough duration to obtain method differences on maintenance and generalization tests as Turnbull (1974) had eight sessions and Borkowski, Cavanaugh, and Reichhart (1978) concluded that at least two sessions are

needed, (2) the training methods might have been too similar in nature to obtain differences, with all three eliciting a type of metamemorial awareness of need for strategy use, and (3) because the children in the study were already implementing some form of verbal rehearsal strategy, the training methods may not have been specifically oriented enough to these children's level of strategy implementation.

Although there were no differences between the three training methods, some conclusions about the training effects in general can be stated. During the actual training trials, group differences in the pre-recency portions of the list, seen as evidence for a basic rehearsal process, were eliminated, thus a result of the training being to limit strategy freedom and flexibility, channeling all learning-age groups into similar strategy implementation. Because during the training session, recency or the evidence for more extended and efficient verbal rehearsal for this task format, was significantly greater than during the pre- and post-intervention sessions for all groups, training (all methods) seemed to have an effect in improving task adaptability and strategy efficiency. All three of the training methods seemed to be equally effective in the generalization to a new task, as all the learning-age groups improved from the pre- to post-intervention session.

In summary, the results of this study revealed a production inefficiency in learning disabled children's use of verbal rehearsal strategies and supported the description of a "developmental lag" in rehearsal strategy development as compared to normal learning children of the same mental and chronological age. Also, it was discovered that metamemory knowledge of some variables may be slow in developing in the learning disabled during early years, but becomes equivalent to normal children by 11 or 12 years of age, except in confidence in memory abilities. Finally, knowledge gained about strategy training was that it can be effective in improving verbal rehearsal efficiency during actual training and results in eliminating group differences and the three training methods of practice, specific strategy and metamemory can be equally effective in immediate and generalization effects. Future investigation should explore other control processes on different tasks with the learning disabled. Also, metamemory knowledge needs to be explored in younger and older learning disabled children than those used in this study to more precisely specify developmental trends and more in-depth probing of these variables, such as interview studies, would expand the current findings. Finally, more extensive training in control processes, using different materials and tasks, and comparing more distinct training techniques would aid in finding the most facilitative tech-

nique with which to remediate the strategy deficiencies learning disabled children seem to exemplify.

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APPENDIX A

METAMEMORY QUESTIONNAIRE

NAME_____ GRADE_____

DIRECTIONS:

This is a worksheet on memory. It is not a test, but is just to learn how children like you learn to remember things. While you are listening to the questions, think very carefully about how you remember and then answer truthfully. Please don't compare answers with your neighbor as it is important to know what you think.

Your teacher will read the questions to you while you follow along silently to yourself. After each question is read to you, think very carefully about the question and how you remember. Then mark an X on the answer you think is the best one. Here are two examples:

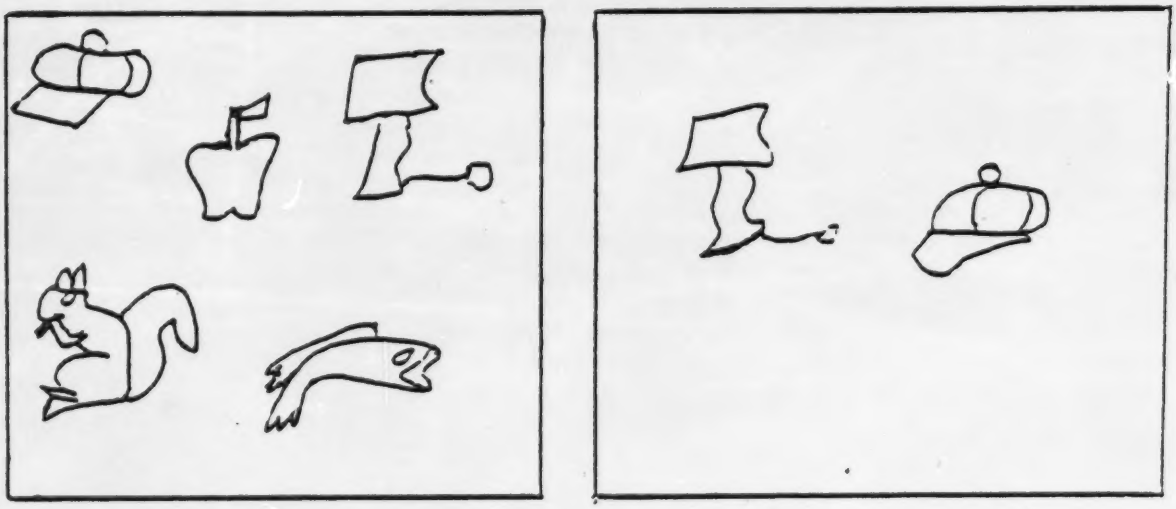
EXAMPLE A

If a man has to remember to buy several things at the store on his way home from work, would it help if he wrote down what he had to buy on a list?

YES NO

EXAMPLE B

If you had to learn the pictures in the boxes, which box would be easier to learn?



You should have put an X on the answer you thought was best.

(Task) 1. If a boy had to remember five different numbers for a math game, would it be easier to do if his turn was first rather than last?

YES NO

(Task) 2. Are some things easier to remember than others?

YES NO

(Strategy) 3. If a boy were trying to learn a list of words, which is the best way to practice them?

study each word alone many times:	study each word in a group with other words:
dog, dog, dog, dog, dog	dog, boy, hat, dog, boy, hat
boy, boy, boy, boy, boy	dog, boy, hat, dog, boy, hat
hat, hat, hat, hat, hat	dog, boy, hat, dog, boy, hat

(Self-concept) 4. Do you remember some things better than your friends?

YES NO

(Task) 5. Which list of words would be easier to learn?

Mary-run	black-white
Ann-sit	boy-girl
Bob-jump	hard-easy
Jim-hop	laugh-cry

(Self-concept) 6. Do you sometimes write down things to help you remember them?

YES NO

(Task) 7. Would it be easier for a boy to remember a story exactly word-by-word than in his own words?

YES NO

(Self-concept) 8. Do you think that you are a good rememberer?

YES NO

(Strategy) 9. Does it make it harder to remember things if you write them down?

YES NO

(Self-concept) 10. Do you remember things you are to do at home, like chores?

YES NO

(Self-concept) 11. Do you remember things like the meanings of words?

YES NO

(Strategy) 12. If a girl were trying to learn a list of words, which would be the best way to learn them?

study each word alone a few times:	study each word alone many times:
pig, pig, pig	pig, pig, pig, pig, pig, pig
cat, cat, cat	cat, cat, cat, cat, cat, cat
sun, sun, sun	sun, sun, sun, sun, sun, sun

(Self-concept) 13. Do you like to play memory games like "Concentration?"

YES NO

(Strategy) 14. When a class is learning how to do a new science experiment, would it help them to remember the way to do it if everyone practiced it in his head first?

YES NO

(Strategy) 15. If a girl were supposed to memorize a long poem for a class play, would it be best to learn it all at one time?

YES NO

(Strategy) 16. If a boy were trying to learn a list of words, which would be the best way to practice them?

study each word in a group with other words:	study each word alone just a few times:
apple, barn, table	apple, apple, apple
apple, barn, table	barn, barn, barn
apple, barn, table	table, table, table

(Task) 17. If a boy wanted to call a friend and someone had just told him the number, would it be better for him to call right away, rather than get a drink of water first and then call?

YES NO

(Task) 18. Is it harder to remember letters in order by yourself than to be able to pick them out from a group of letters on a page?

YES NO

19. Did you think this worksheet was fun?

YES NO

APPENDIX B

POST-TASK INQUIRY

PRE-INTERVENTION SESSION

(Strategy)	1.	Did you do anything to help you to remember the letters?
(Strategy)	2.	Did you do anything to help you to remember the pictures?
(Strategy)	3.	Show me what you did to help you remember the letters.
(Strategy)	4.	Show me what you did to help you to remember the pictures.
(Self-concept, Evaluation)	5.	How do you think you did on these memory games?
(Self-concept, Evaluation)	6.	Were the games easy or hard for you?
(Task)	7.	Was either of the games harder for you? If so, which one?

POST-TASK INQUIRY
TRAINING SESSION

(Strategy)	1.	Did you do anything to help you remember the pictures?
(Strategy)	2.	Show me what you did to help you remember the pictures.
(Self-concept, Evaluation)	3.	How do you think you did on this memory game?
(Self-concept, Evaluation)	4.	Was the game easy or hard for you?

POST-TASK INQUIRY
POST-INTERVENTION SESSION

(Strategy)	1.	Did you do anything to help you remember the letters?
(Strategy)	2.	Did you do anything to help you remember the pictures?
(Strategy)	3.	Show me what you did to help you remember the letters.
(Strategy)	4.	Show me what you did to help you remember the pictures.
(Self-concept, Evaluation)	5.	How do you think you did on these memory games?
(Self-concept, Evaluation	5a.	Do you think you did better or worse than the other times?
(Self-concept, Evaluation)	6.	Were the games easy or hard for you?
(Self-concept, Evaluation)	6a.	Were they easier or harder for you than before?
(Task)	7.	Was either of the games harder for you? If so, which one?
(Training)	8.	Did you use the trick/plan/way you learned/found last week to help you to remember the letters and pictures?
(Training)	9.	What was the trick/plan? Describe it.
(Task)	10.	What are some other times you might have to remember things like this?